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ABSTRACT:

Gallium nitride with wurtzite crystal structure is a chemically stable semiconductor with high internal spontaneous and piezoelectric polarization, which make it highly suitable materials to create very sensitive and robust sensors for the detection of ions, gases and liquids. Sensing characteristics of an open-gate liquid-phase sensor fabricated on undoped-AlGaN/GaN high-electron-mobility-transistor (HEMT) structure in aqueous solution was investigated. In ambient atmosphere, the open-gate undoped AlGaN/GaN HEMT clearly showed only the presence of linear region of currents while Si-doped AlGaN/GaN showed the linear and saturation regions of currents, very similar to those of gated devices. This seems to show that very low Fermi level pinning by surface states exists in undoped AlGaN/GaN sample. In aqueous solution, the typical current-voltage (I-V) characteristics of HEMTs with good gate controllability were observed. The potential of the AlGaN surface at the open-gate area is effectively controlled via aqueous solution by Ag/AgCl reference gate electrode. The open-gate undoped AlGaN/GaN HEMT structure is capable of stable operation in aqueous electrolytes and exhibit linear sensitivity, and high sensitivity of 1.9 mA/pH or 3.88 mA/mm/pH at drain-source voltage, VDS = 5 V was obtained. Due to large leakage current where it increases with the negative reference gate voltage, the Nernstian's like sensitivity cannot be determined. Suppression of current leakage is likely to improve the device performance. The open-gate undoped-AlGaN/GaN structure is expected to be suitable for pH sensing application.